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(54) IMPROVEMENTS IN FLUID BEARING ASSEMBLIES

(71) We, LIDKOPINGS MEKANISKA VERKSTADS AB., a Swedish Body Corporate, of 531 00 Lidkoping, Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to fluid bearing assemblies.

The invention provides a fluid bearing assembly comprising first and second relatively movable elements, means for supplying fluid to the bearing and a throttle in said supply means which throttle is formed by adjacent surfaces of the elements, the arrangement being such that variation in the separation of said adjacent surfaces of the elements varies the flow of fluid to the surfaces of the elements to centre the second element between opposed surfaces of the first element, or between opposed portions of a continuous surface of said first element, wherein the throttle comprises an inner pocket in the surface of one element to which fluid is supplied and an outer surrounding pocket which is provided with an outlet for the fluid which outlet is connected to an associated fluid bearing in one of the opposite surfaces of said element.

The fluid bearing may comprise a pocket formed in a surface of one of the elements.

If the medium used for forming a slide cushion is a liquid the bearing is commonly called a hydrostatic bearing, and if the medium is a gas the bearing is commonly called an aerostatic bearing.

The most natural medium to use for forming a slide cushion would be oil, but it should be obvious, as previously mentioned, that any medium whatsoever that has properties for forming a slide cushion can be used.

Further characteristic features of the present invention will be noted from the following claims.

Embodiments according to the present invention will now be described by way of example with reference to the attached drawings, in which:—

Figure 1 shows a parallelepipedical machine element, provided with throttles and pockets according to the present invention for forming of slide cushions, which are arranged on two opposite vertical sides,

Figure 2 shows a cut-away view of the front part of the parallelepipedical element,

Figure 3 shows a machine element similar to that shown in Figure 1, but having the throttles and pockets for forming slide cushions arranged on the opposite horizontal sides,

Figure 4 shows a machine element provided with throttles and pockets for forming slide cushions on all four sides, the pockets and throttles on one side coacting with the corresponding members on the opposite side,

Figure 5 shows a practical application of a machine element, the machine element functioning as a guide rule for a reciprocating table, for instance a machine tool,

Figure 6 shows a part of Figure 5 enlarged,

Figure 7 shows a more or less cylindrical member which has throttles and pockets for forming slide cushions arranged in pairs around the periphery of the cylindrical member, and

Figure 8 shows schematically the channels for one of the peripheral series of throttles and pockets.

Referring to Figures 1 and 2 of the drawings, there is shown an elongate parallelepipedical element or rule 1 which comprises two vertical walls 2 and 3. The element is provided with four pockets three of which 4, 5 and 6 are shown in the drawings. The fourth pocket acts in association with pocket 5, while the pockets 4 and 6 coact with each other. Each of the pockets are surrounded by a flat surface 7, 8 and 9

respectively, which surfaces form raised sections in relation to the walls 2 and 3, and are intended to coact with vertical walls in a guide groove for the element 1. Each of the pockets has an inlet hole two of which 10 and 11 are shown in pockets 4 and 5 respectively. A throttle 12 is located adjacent the edge of pocket 4 remote from pocket 5 and a throttle 13 located adjacent the edge of pocket 5 remote from pocket 4. A throttle 14 is located in wall 3 opposite throttle 12 and adjacent pocket 6. The pocket on side 3 of the element, which coacts with the pockets 5, also has an associated throttle (not shown). The throttles 12, 13 and 14 each comprise pockets 15, 16 and 17 respectively. Each of the pockets 15, 16 and 17 is surrounded by a raised section, or land, 17A, 18 and 19 respectively, which has a flat upper surface which surface is flush with the flat surfaces surrounding the adjacent pockets 4, 5 and 6 respectively. These flat surfaces form a part of the fluid bearing. The peripheral lands 17A, 18 and 19 in each of the throttles 12, 13 and 14 is surrounded by a peripheral pocket 20, 21 and 22 respectively and the peripheral pockets 20, 21 and 22 are each surrounded by a surface which constitutes a seal for the peripheral pocket, and have the reference numerals 29, 30 and 31 respectively. The last-mentioned surfaces are flush with the upper surfaces of the peripheral lands. A feed pipe 32 for supplying oil to the element 1 is located at one end of the element. Inside the element, a branched channel 33 has been drilled, which has an outlet orifice 26 in the pocket 15 and an outlet orifice 28 in the pocket 17. The peripheral pockets in all of the throttles each have an outlet orifice 23, 24 and 25 respectively. Each of the outlet orifices 23, 24 and 25 constitute one end of a drilled channel 34 and 35, respectively, which are not connected together. The channel 35 emerges into the pocket 6, and the channel 34 into the pocket 4. The inlet 11 is also connected to a channel which emerges into a throttle located on the other side, the throttle 13, and the outlet orifice 24 of the throttle 13 emerges into a pocket opposite the pocket 5. For the two pairs of throttles and pocket forming a slide cushion in the right hand end of the element there is a feed pipe 36.

If an elongate machine element of the kind described is arranged between two vertical walls, in order to achieve guidance of the element, the maintaining of slide cushions of the same thickness functions in the following way. Oil is fed to the pipe 32, and from there to the pocket 15 and the pocket 17, respectively via the branch pipe 33. If the element is correctly centered in relation to the vertical walls, equal quantities of oil, at the same pressure, will flow out through the two inlet orifices 26 and 28. If the throttle at part 12 is considered, this will be sufficient as the situation at part 14 is identical. Thus, oil now flows through the inlet orifice 26 into the pocket 15, and thereafter between the space formed by the flat upper surface of the raised part of the peripheral land and the surrounding guide wall into the peripheral pocket 20. From this pocket a small portion flows as leakage onto the peripheral surface 29, and the rest of the oil through the outlet orifice 23, the channel 35 and into the pocket 6, and there, on its surrounding surface forms a peripheral fluid bearing. Similarly oil supplied to throttle 14 will be fed to pocket 4. If, for any reason, the distance between the upper surface of the peripheral land 17A and the opposite vertical guide wall should be less than the corresponding distance at part 14, the peripheral land 17A will throttle down and thereby oil will be supplied at a lower pressure to the channel 35 and, accordingly, to the pocket 6, but there will be less throttling at the peripheral land 19 and, consequently, an increase in the oil pressure supplied to the pocket 4 from part 14, and the element will then be caused to assume a central position in relation to its vertical walls, since the force of the oil pressure in the pockets 4 and 6 is greater than the force exerted by the oil from the throttling part. In the same way, the throttle 13 and the pocket 5 will function together with the corresponding pair located on side 3 of the machine element. Along the length of the machine element, two pairs each pair consisting of throttle and pocket have been arranged, but it should be obvious that more pairs can be arranged along the length of the element should this be desired.

Figure 3 shows a machine element similar to that shown in Figures 1 and 2. The only difference is that each pair of throttles and pockets forming the slide cushion have been arranged on two opposite horizontal surfaces. This figure also shows how two such pairs have been arranged at either end of the element, each pair consisting of a throttle and a pocket for achieving a slide cushion. In this case the element is to be throttled between two horizontal walls. The element has here been given the reference designation 1'. The uppermost horizontal surface has been given the reference designation 37 and the lowermost horizontal surface the reference designation 38. The three pockets shown for forming slide cushions have been given the reference numerals 39, 40 and 43, the throttles the reference numerals 41, 42 and 44, and drilled channels the reference numerals 45, 46 and 47, which channels are not connected to each other. The element will be guided in a

similar way between two horizontal walls as the element shown in Figure 1 was guided between two vertical walls.

Figure 4 shows an element 1″, which is intended to be guided between four walls. In other words, this element constitutes a combination of those shown in Figures 1 and 3. In the figure there is shown an oil feed pipe 32″. The feed pipe 32″ is connected to a drilled channel 33″ in the element, which supplies oil to four throttles. Only one vertically disposed throttle 12″ and one horizontally disposed throttle 49″ is shown for clarity. Pockets 4″ and 39″ are located adjacent throttles 12″ and 49″ respectively which coact with said throttles in the way previously described, with the aid of the drilled channels 46″ and 47″. At the opposite end of the element there are also shown pockets 5″ and 40″ for forming slide cushions, and their associated throttles parts 13″ and 42″. For the last-mentioned centered units, the supply of pressure medium is arranged through the pipe 36″. The channels 34″, 46″ and 47″ and the corresponding pipes are not connected with each other.

Figures 5 and 6 show a practical application of the machine elements described in the foregoing. Thus, 48 is a table which is intended to have a reciprocating movement and which is intended to be suitable arranged on a machine tool. The turret of a turret lathe, for instance, can be mounted on the table. On its under side, the table is provided with longitudinal flanges 49 and 50, which are fixed to the table. On the under sides of each of the flanges, elements according to the foregoing figures are attached, and said elements, which here have been given the reference designations 51 and 52, each run in a four-walled groove 53 and 54 respectively. The centering parts on the uppermost and lowermost faces of the elements 51 and 52 function in the same way as described with reference to Figure 3. The horizontal guidance of the elements 51 and 52, takes place in the same way as shown in Figure 1. The above-mentioned grooves 53 and 54 are arranged in a support 55.

Figure 7 shows a cylindrical member 56. Along its peripheral surface it is provided with pairs of throttle parts and fluid bearing pockets, divided up into two series, which are arranged at axially spaced locations indicated at 57 and 58. In the figure there are three such pairs at the first location 57. The same applies to the pairs at the second peripheral location 58. There can thus be seen at the first peripheral location a throttle 59 of one pair and two pockets 60 and 61 forming slide cushions of two further pairs, and at the second peripheral location two throttles 62 and 63 for two said pairs and a pocket 64 for a third of said pairs. The throttle part 59 consists of a pocket 65, a raised section 66 of the periphery, a pocket 67 containing an outlet, and a peripheral raised section 67A which serves as a seal. The pocket 65 contains an inlet. The two pockets 60 and 61 have an inlet 68 and 69, respectively. The throttle 62 has a pocket 70 with inlet, a peripheral raised section 71, a peripheral pocket 72 with an outlet and a peripheral raised section 72A serving as a seal. The pocket 64 has an inlet 73. For the three pairs along the two peripheries, it is considered appropriate to arrange in each periphery so that each pair is located at a distance of 120° in relation to each other.

Figure 8 shows how the channels for the first series of throttles and pockets for forming slide cushions are arranged. The channel 75 emerges into the pocket 65. The channel 76 emerges into the pocket for the throttle which is located diametrically opposite the pocket 61, and the channel 77 emerges into the pocket for the throttle which is diametrically opposite the pocket 60. The peripheral pocket 67 is connected to the channel 78, which connects the pocket with the diametrically opposite pocket for forming a slide cushion. The channel 69 is connected with the peripheral pocket for the throttle which is opposite the pocket 61. In the same way, the channel 68 is connected with the throttle diametrically opposite the pocket 60.

From the foregoing, it will be noted that it has been possible to achieve slide cushion suspension of machine elements which are either rotatable or movable in such a way that they are self-centering, the throttles which are required in order to achieve these slide cushion suspension arrangements have no movable parts and utilize the peripheral wall of the machine element and the guide wall facing same, and the throttle being adjacent to a pocket for forming the slide cushion. Such a pair coacts with a second pair by means of a cross connection, which involves that the throttle at a pocket feeds pressure medium to the pocket adjacent to the throttle in the second pair. This combination of two cross-connected pairs can be used for a plurality of applications further to those described in the foregoing.

By using self-centering of the above-mentioned kind, since the arrangement only consists of drilled channels and surfaces, an advantage is gained in that no assembly work is required in order to achieve the throttles, that no incorrect after-adjustments of the throttles can be made, and, further, that the throttles owing to their large periphery are insensitive to small particles of foreign matter, and since the element with throttles is intended to be in motion while in operation, particles of foreign

matter if any, will pass through the throttle together with the pressure medium.

In the foregoing, it has been indicated that milled recesses have been made for the pockets and the throttles in the movable elements, but it should be obvious that these recesses can also be made in the surrounding walls, and the movable elements will then have entirely smooth surfaces.

WHAT WE CLAIM IS:—

1. A fluid bearing assembly comprising first and second relatively movable elements, means for supplying fluid to the bearing and a throttle in said supply means which throttle is formed by adjacent surfaces of the elements, the arrangement being such that variations in the separation of said adjacent surfaces of the elements varies the flow of fluid to the surfaces of the elements to centre the second element between opposed surfaces of the first element, or between opposed portions of a continuous surface of said first element, wherein the throttle comprises an inner pocket in the surface of one element to which fluid is supplied and an outer surrounding pocket which is provided with an outlet for the fluid which outlet is connected to an associated fluid bearing in one of the opposite surfaces of said element.

2. A fluid bearing assembly as claimed in claim 1 wherein the fluid bearing comprises a pocket formed in a surface of one of the elements.

3. A fluid bearing assembly as claimed in either of the preceding claims and wherein the first element has two opposed surfaces between which the second element is slidable the fluid bearing being provided between one of said opposed surfaces and one side of the second element and the throttle being provided between the other opposed surface and the other side of the second element.

4. A fluid bearing assembly as claimed in claim 3 wherein there is a fluid bearing between both sides of the second element and the opposed surfaces of said first element each bearing having a throttle between a side of the second element and one of said opposed surfaces, the throttle being on the opposite side of the second element to the fluid bearing.

5. A fluid bearing assembly as claimed in claim 4 wherein the first element surrounds the second element and a plurality of fluid bearings is provided between the first and second elements, each bearing having an associated throttle on the opposite side of the second element to the bearing.

6. A fluid bearing assembly as claimed in any of claims 3 to 5 wherein a plurality of fluid bearings is formed between the or each opposed surface of the first element and an adjacent surface of the second element.

7. A fluid bearing assembly as claimed in any of claims 3 to 6 and where the throttle is provided by inner and outer pockets in a surface wherein said inner and outer pockets of the or each throttle are formed in a surface of the second element.

8. A fluid bearing assembly as claimed in any of claims 3 to 7 and where the fluid bearing is formed by a pocket in a surface and wherein the pocket of the or each fluid bearing is formed in the second element.

9. A fluid bearing assembly as claimed in any of claims 3 to 8 wherein the second element is rectangular in cross-section.

10. A fluid bearing assembly as claimed in claim 9 wherein the first element is formed with a four walled passage in which the second element is slidable.

11. A fluid bearing assembly as claimed in any of claims 3 to 8 wherein the second element comprises a rotatable shaft.

12. A machine element supported by fluid bearing assemblies substantially as described with reference to and as illustrated in Figures 1 and 2 or 3, or 4 or 5 and 6 or 7 and 8 of the accompanying drawings.

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1,362,976 COMPLETE SPECIFICATION
7 SHEETS

This drawing is a reproduction of the Original on a reduced scale.
SHEET 1

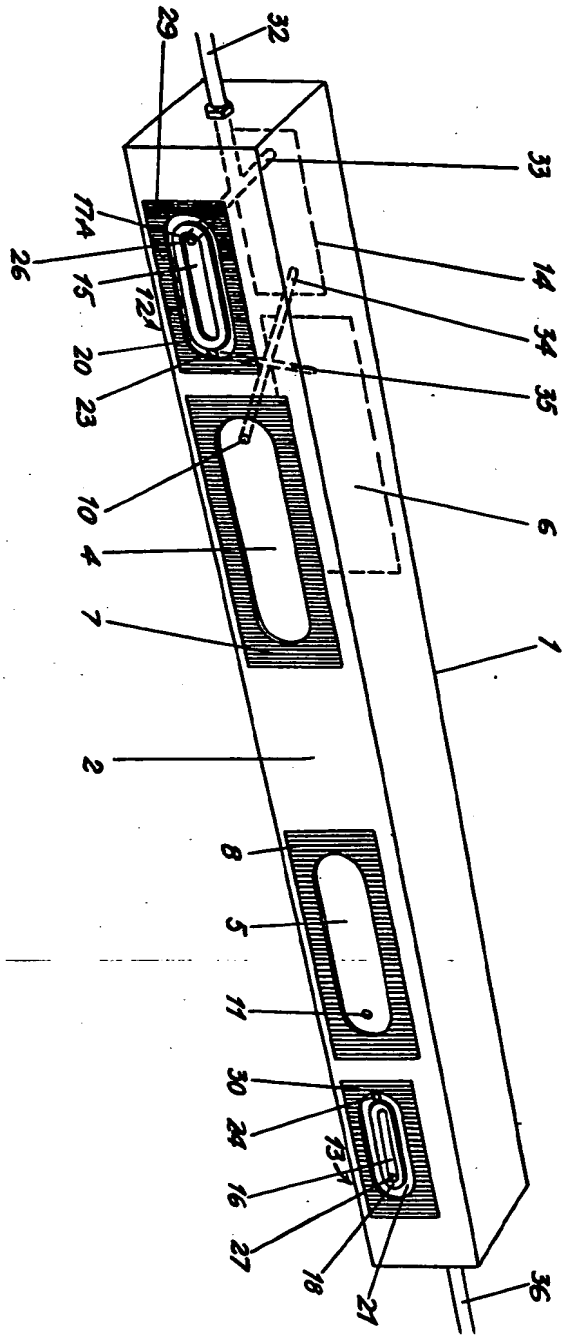


Fig. 1.

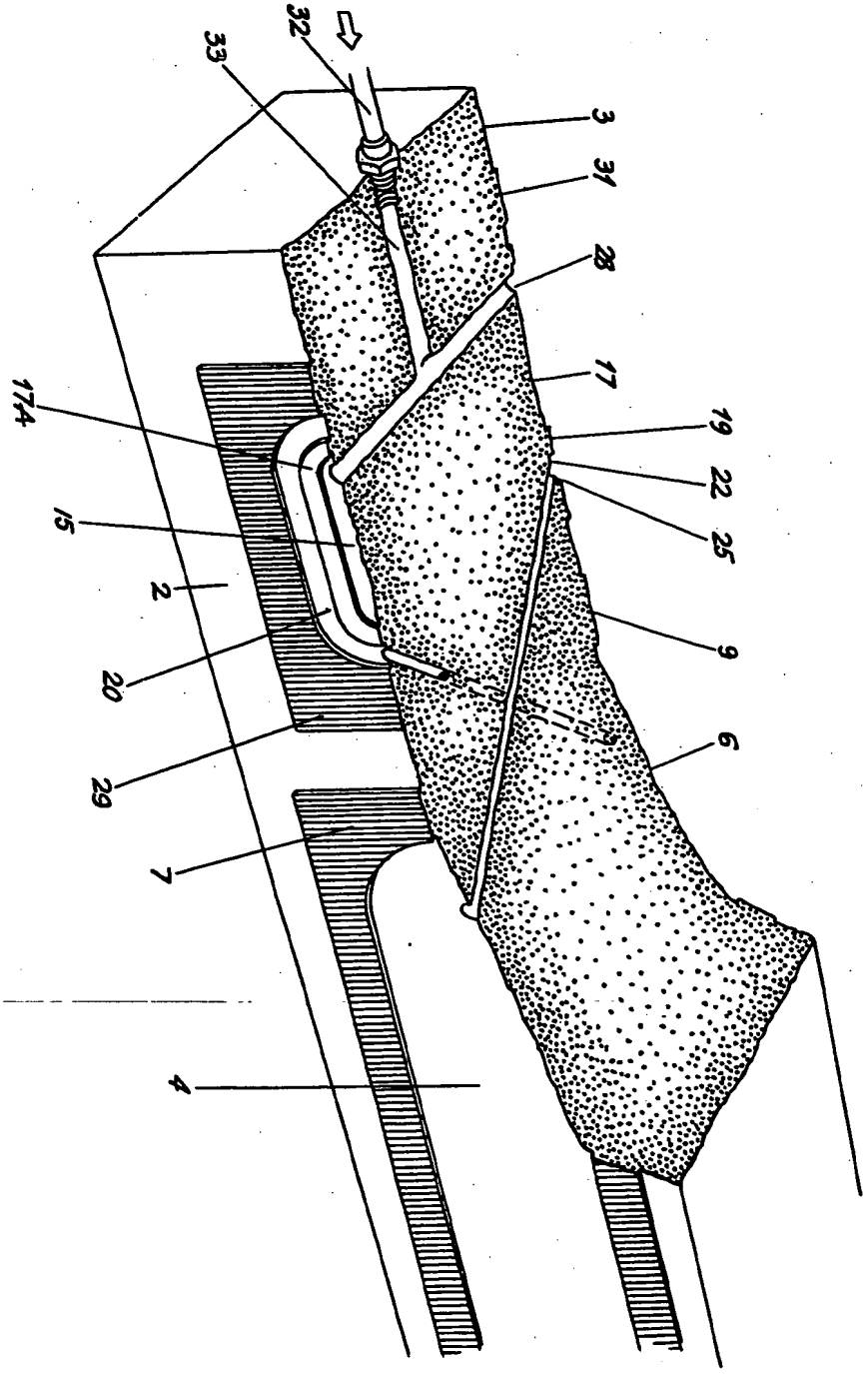


Fig. 2.

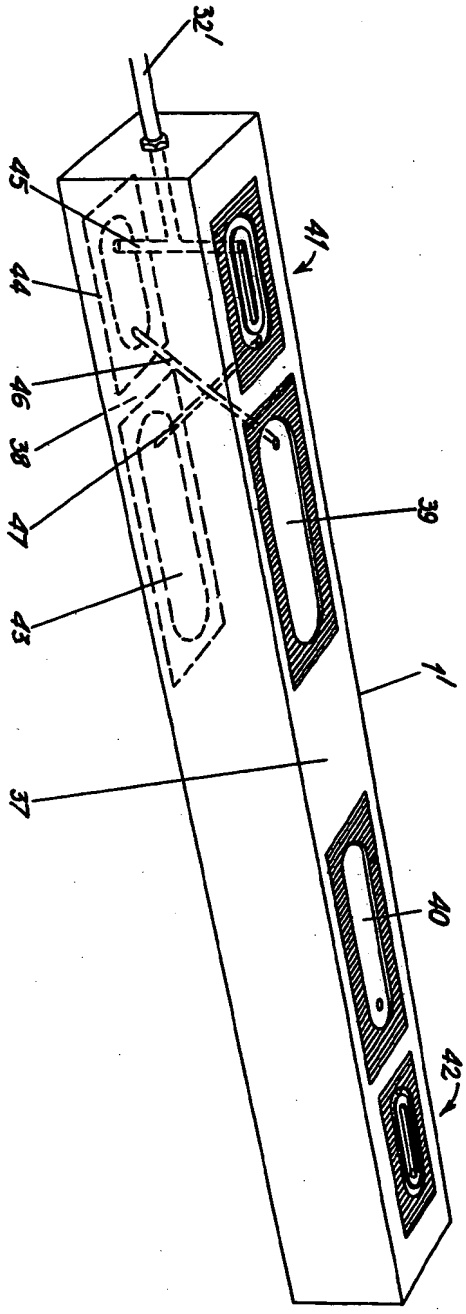


Fig. 3.

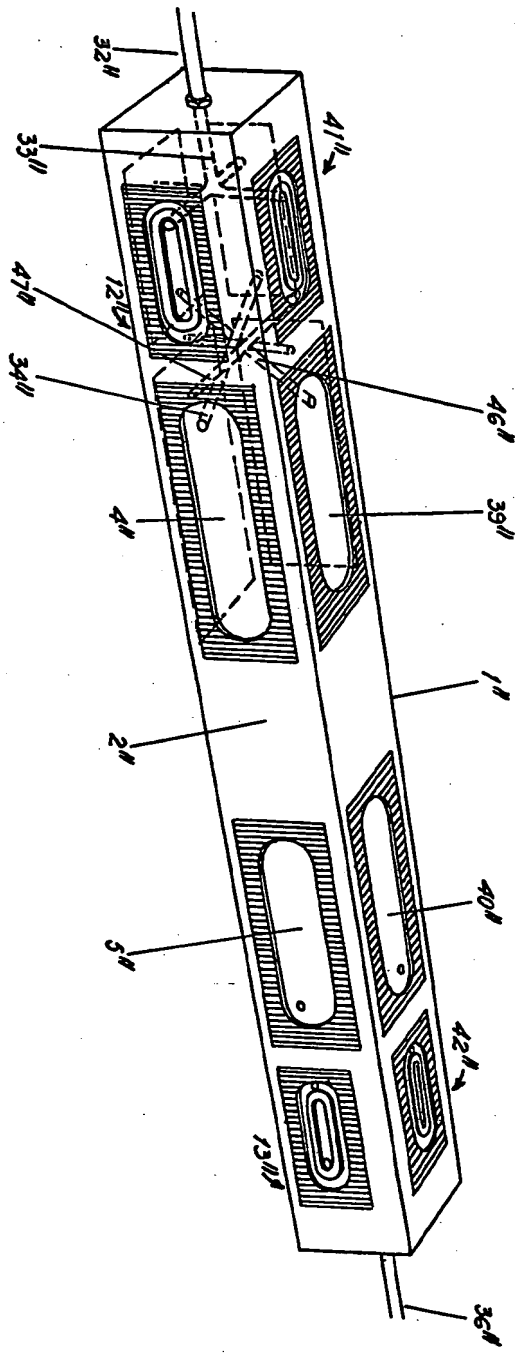


Fig. 4.

Fig. 5.

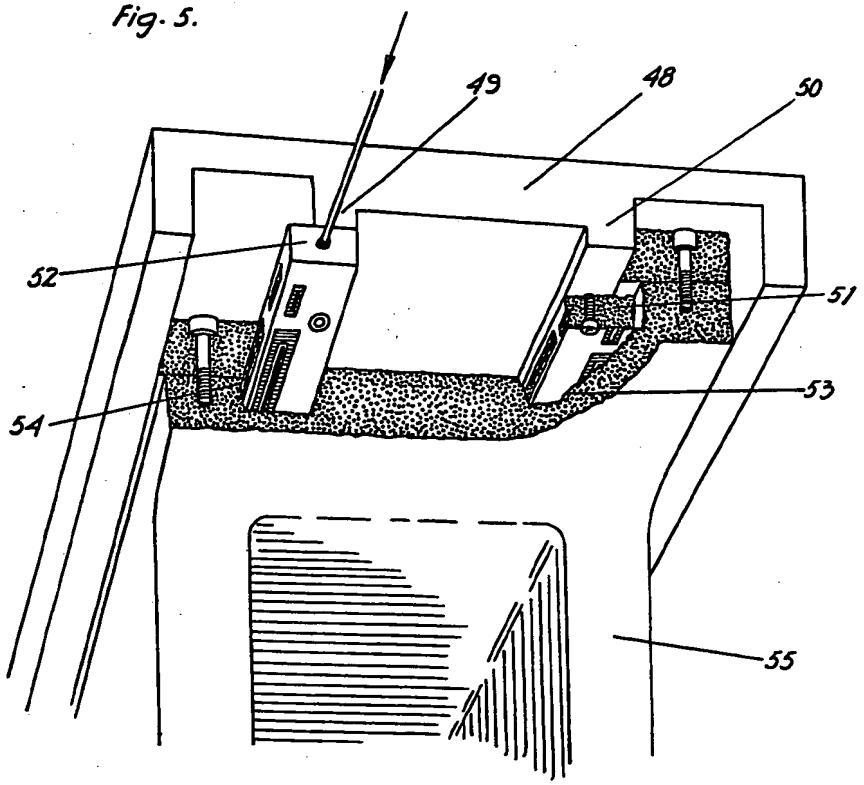
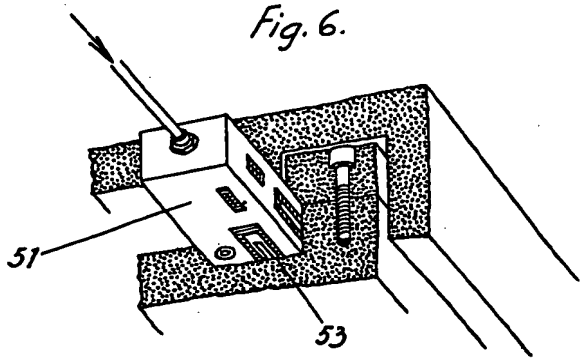


Fig. 6.



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7 SHEETS

COMPLETE SPECIFICATION

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SHEET 6

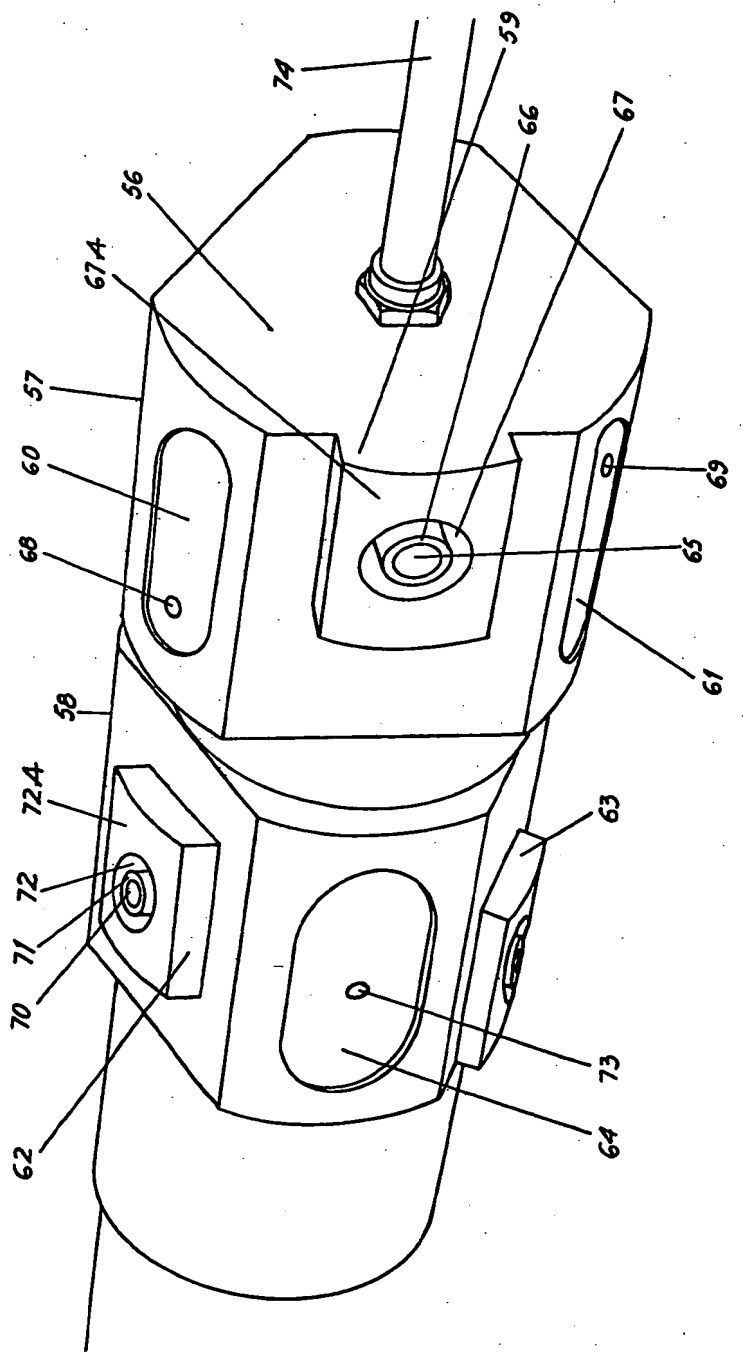

Fig. 7

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COMPLETE SPECIFICATION

Fig. 8